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Receivers' response to new urban freight policies

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Abstract

In the last decades, urban freight deliveries (UFD) have raised considerably. Freight vehicles hamper mobility, slowing down the traffic and sometimes double parking. In general, UFD coincides with peak-hour traffic, because deliveries have to be made during business hours.

Some cities worldwide have adopted actions aimed to reduce freight vehicles circulating in peak-hours, but such actions usually come up against the receivers, who are not willing to change how they receive their goods.

This paper shows the main results of a project carried out in two Spanish cities, a big-sized city (Barcelona) and a medium-sized one (Santander), about the receiver's will to adopt new delivery policies. In particular, an off-peak deliveries (OPD) policy and an urban distribution centers (UDC) policy have been analyzed. Subsequently, these results will be compared with those obtained in NYC for OPD.

Through a stated preference survey, we have investigated how each variable of these policies influence the receiver's decision. As a result, we developed a different freight policy choice model for each city. To build the models, we used a mixed logit model considering repeated observations (panel data) and taste variations.

In the light of the results obtained, the receivers are more willing to adopt an UDC policy, especially in Barcelona, whose receivers oppose firmly OPD.

As expected, the incentives strongly influence receivers to adopt these policies; however, this influence is quite more important in certain business sectors, such as food (for OPD in Barcelona), restaurant and hotel, and furniture (for UDC in Santander and Barcelona, respectively). This goes along the lines of the results from NYC, where there are seven sectors more sensitive to the incentives.

Therefore, it is possible to achieve a behavioral change in UFD, by combining these policies and targeting the incentives on specific business sectors in order to achieve better results.

Keywords: freight transport, urban freight deliveries, stated preference survey, discrete choice models

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1. Introduction

Over recent years greater or lesser success has been achieved in trying to improve goods distribution in urban areas. Among the more noteworthy policies are those aimed at promoting the use of collaborative transport systems and those trying to reduce heavy vehicle traffic at rush hours.

The policies promoting the use of collaborative distribution systems try to reduce the number of required journeys and increase average vehicle load factors (which are generally around 30-40%), by looking for collaboration between companies. The use of cooperative transport systems has been studied for many decades in spite of the practical difficulties involved in finding agreements between different companies. Research carried out by the Tri-State Transportation Commission in 1970 (Wood, 1970) indicated that the use of cooperative systems would result in a 12% reduction in overall operating costs, 50% in parking time and 90% in round trip time. In spite of the difficulties, there have been some noteworthy successful collaborations between companies for urban goods distribution, such as in Fukuoka, Japan (Ieda et al., 2001), Fribourg, Switzerland (Kohler, 2001), Kassel and Munich, Germany.

An initial example of a collaborative system is the joint delivery service (JDS), by which a group of carriers create a neutral company whose job it is to carry out the final mile in the goods distribution chain. This solution increases vehicle usage and at the same time shortens journeys (see fig. 1).

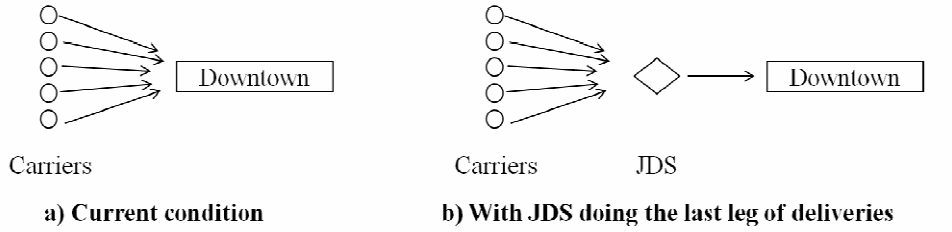

Fig. 1. Deliveries to an urban centre without JDS (a) and with JDS (b) (Holguín-Veras et al., 2007)

Research carried out to evaluate the efficiency of JDS (Kawamura and Lu, 2008) has found that its use is only profitable when there are high densities of traffic and small vehicles are used. Therefore, to encourage companies to take up these solutions they must be given incentives.

The policies aimed at encouraging some goods vehicles to use alternative timetables rather than typical commercial hours are a result of distribution vehicles being an important factor in urban traffic congestion at rush hours. Although some cities such as Beijing have introduced a total ban on goods transport during the day time this has only moved the problem from the day to the night, the best solutions have been found to be those which transfer a large percentage of the distribution vehicles to off peak traffic periods.

The most used policy is generally that of goods distribution at night time. Some successful policies have been introduced in cities as populous as New York, where a pilot test carried out in Manhattan found reductions in journey times of over 6% with 10% of the carriers taking part (Holguín-Veras et al., 2011). Furthermore, substantial improvements are found in urban traffic congestion and environmental pollution, resulting in an increase in the economic competitively of the towns and cities involved.

Although these policies have frequently been adopted to reduce the traffic congestion caused by the circulation of goods vehicles at rush hour, it is also important to consider the point of view of the receivers who usually oppose these policies because they are unwilling to change the way they receive their goods.

This paper aims to analyse the differences in the behaviour of the receivers in response to new urban goods distribution policies, using a model to predict the change in receivers' attitude. These changes do not only depend on the characteristics of each policy but also on the type of business being affected.

Two policies will be studied, both aimed at avoiding the circulation of delivery vehicles at rush hour: night time distribution and the use of urban goods distribution centres. These policies will then be compared with the results obtained in NYC using OPD.

An initial selection is made of the main variables affecting each of the policies being studied and a stated preferences survey is then asked to the retailers in order to analyse their predisposition to accept each of the policies. The results of the surveys will be used to calibrate a mixed Logit model considering repeated observations (panel data) and interactions with the type of business being affected by the policies being studied. This model will allow the later study of how the businesses behave as a result of changes made to urban goods distribution policies. The creation of the model will be followed by simulating the two systems for urban goods distribution to estimate the importance of each variable on the decisions made by the businesses. The results obtained for Santander and Barcelona will then be compared with those found in NYC to find if there are any similarities and differences.

This paper is structured in the following way: section 2 provides a detailed description of the analysis carried out, explaining the policies and the most important variables, as well as explaining how the stated preferences surveys were designed. Section 3 describes the calibration of the model for predicting the behaviour of the receivers in response to the new policies and Section 4 evaluates this behaviour in Santander and Barcelona. Section 5 compares the results obtained in these two cities with those found in NYC using OPD and, finally, section 6 presents the most important conclusions.

2. Description of the analysis performed

This paper studies the behaviour of goods receivers (retailers and hostelry) in response to the introduction of new urban goods distribution policies, specifically Off Peak Deliveries (OPD) and the use of Urban Distribution Centres (UDC) for goods. The first of these policies uses the off peak distribution of goods (OPD) which aims to transfer the distribution of some goods from rush hour to night time (between 22:00 and 6:00) whilst taking remedial measures to counter any irritation to both residents and business.

The second of the collaborative transport system policies being analysed uses urban goods distribution centres (UDC). This policy encourages the arrival of goods at the distribution centres during the night time and from there the goods are delivered in smaller, preferably more environmentally friendly vehicles during commercial hours, thereby not only reducing traffic congestion at rush hour but also reducing pollution. Consideration is finally made of the current situation in urban goods distribution as the third policy to follow (this is really a policy of “inaction”).

These policies will be presented to the receivers to consider their preferences under different scenarios because they are the ones who are really responsible for choosing how and when goods should be distributed in our towns and cities (Holguín-Veras et al., 2007; Holguín-Veras et al., 2008). The responses provided by the businesses will allow us to calculate how many and which of them would be willing to use each of the different policies.

2.1. Choice of the relevant variables for each policy

Many studies have tried to determine the most significant variables for different urban goods distribution policies (Marcucci and Danielis, 2008; NCFRP, 2010). A detailed study should be carried out in each case to determine the main variables affecting policies defined for each city as differences may exist from one place to another. The procedure will involve holding a series of interviews with various focus groups made up of people who are directly involved in the urban distribution of goods, i.e, distributors, carriers and businesses. Among other things, these interviews will be used to ask them which variables they think are the most important within each of the proposed policies. They will then be asked about the importance they would place on a series of variables which turned out to be significant in other studies from around the world (Holguín-Veras et al., 2007).

The importance of the variables highlighted in the focus groups was confirmed by the stated preferences survey. Some of the variables were common to the two policies (for example, the amount of incentives provided for taking

part in the policies), while others were specific to each policy. Table 1 presents the variables which turned out to be most significant for the present study. Some of the variables were later divided into two or more dummy variables for reasons of functionality.

Table 1. Relevant variables for the studied policies

OPD	UDC
Tax incentive	Tax incentive
Goods delivery system	Reduction of stock held on premises by having space available at UDC
Goods delivery time table	Distance between the UDC and the business
	Goods delivery timetable

2.2. Stated preferences survey presented to retailers

An efficient design was used to correctly design the stated preferences survey, in order to maximise the information obtained from each choice situation. The efficiency was measured by using a measure which tries to minimise the error, the most commonly used in the literature is known as D-error (Bliemer and Rose, 2006), which uses the determinant of the asymptotic variance-covariance matrix.

The results from the pilot survey (relevant variables and 'a priori' values of the parameters which improve the experimental design) were used to design the final stated preferences survey. The experimental design resulted in 12 choice scenarios to be presented to each interviewee. Experience showed that to ask a stated preferences survey with too many scenarios is not a good idea (Pearmain et al., 1991; Sanko, 2001) because the interviewee tires and after a certain moment stops thinking about the answer (because they want to finish as quickly as possible). This problem was avoided by dividing the 12 scenarios into two balanced blocks of 6 scenarios so the interviews replied to the survey as accurately as possible. This method provided more trustworthiness to the replies.

The advantage of stated preferences surveys is that given that each interviewee is presented with various scenarios in the same questionnaire (in this case 6 choice scenarios), a high number of questionnaires does not need to be collected to obtain a decent confidence level. Experience has demonstrated that for medium sized cities like Santander collecting 200 valid questionnaires is enough. This method provides 1200 different observations, although when estimating the mixed logit model consideration it must be considered repeated observations (only one policy can be chosen at a time).

3. Model for predicting the behaviour of goods receivers

As mentioned previously, a mixed logit model was used to model the results of the analysis as this type of model better adapts to the simulation of user behaviour (in this case, the retailers). These models are based on random utility theory (Domencich and McFadden, 1975). It needs to be pointed out that the mixed Logit model includes repeated observations as the data come from a stated preferences survey and, therefore, the interactions between the variables and the types of commercial activity have been included, as there is a suspicion of heterogeneity in the preferences of different commercial sectors.

The definitive models were obtained from the completed model specification; they were then calibrated using simulation. A Halton sequence was chosen rather than the more typical Montecarlo simulation, because the pseudo random values have a more uniform distribution throughout the interval (Bhat, 2000).

3.1. Model of receiver behaviour in Santander

The best model for Santander takes into account the main variables being considered, even though two of the OPD variables and another two from UDC were not significant, meaning they were excluded from the model. This model provided the following utility functions, in which the parameters are represented in lower case and the variables in upper case:

$$U(OPD) = c_{OPD} + tax_{OPD}\, TAX_{OPD} + tax_{OPD,FO}\, TAX_{OPD,FO} + ciw_{OPD}\, CIW_{OPD} + cew_{OPD}\, CEW_{OPD} + ret1_{OPD}\, RET1_{OPD} \quad (1)$$

$$U(UDC) = tax_{UDC}\, TAX_{UDC} + tax_{UDC,RH}\, TAX_{UDC,RH} + dis_{UDC}\, DIS_{UDC} + dis_{UDC,TX}\, DIS_{UDC,TX} + dis_{UDC,FU}\, DIS_{UDC,FU} \quad (2)$$

$$U(CUR) = cur \quad (3)$$

Table 2 presents the estimation of the ML model with repeated observations and interaction between the variables and the commercial activity. The table also shows the values of the standard deviation of the random estimated parameters. The software NLOGIT was used for calculating the models.

Table 2. Best model for analysing the behaviour of goods receivers in Santander

Variable	Name	Coefficient	Test-t	P[|Z|>z]
Specific constant of the OPD alternative	c_{OPD}	-3.0924	-5.822	0.0000
Tax incentive offered to businesses to use the OPD alternative	tax_{OPD}	7.8999	2.589	0.0096
Variable worth $TAX_{OPD,FO} = TAX_{OPD}$ if the business is part of the food sector, 0 in other cases	$tax_{OPD,FO}$	3.8652	1.105	0.3542
Dummy variable, $CIW_{OPD} = 1$ if the carriers unload the goods in a warehouse inside the business and 0 in other cases	ciw_{OPD}	1.4509	3.001	0.0027
Dummy variable, $CEW_{OPD} = 1$ if the carriers unload the goods at a warehouse outside the business and 0 in other cases	cew_{OPD}	1.8715	4.292	0.0000
Dummy variable, $RET1_{OPD} = 1$ if the business receives the goods at their premises between 22.00 and 24.00 and 0 in other cases	$ret1_{OPD}$	1.1166	2.284	0.0224
Tax incentive offered to businesses to use the UDC alternative	tax_{UDC}	5.5290	4.262	0.0000
Variable worth $TAX_{UDC,RH} = TAX_{UDC}$ if the business belongs to the hostelry sector and 0 in other cases	$tax_{UDC,RH}$	8.3241	2.965	0.0030
Distance from the UDC to the business	dis_{UDC}	-0.0005	-1.964	0.0496
Variable worth $DIS_{UDC,TX} = DIS_{UDC}$ if the business belongs to the textile sector and 0 in other cases	$dis_{UDC,TX}$	0.0015	5.445	0.0000
Variable worth $DIS_{UDC,FU} = DIS_{UDC}$ if the business belongs to the furniture sector and 0 in other cases	$dis_{UDC,FU}$	0.0083	1.857	0.0633
Standard deviation of the variable $DIS_{UDC,FU}$	$Ns\_dis_{UDC,FU}$	0.0283	2.050	0.0404
Specific constant of the alternative CUR	cur	1.2466	7.118	0.0000
Nº observations		1200		
Log-likelihood		-1020.372		

3.2. Behaviour model for the receivers of goods in Barcelona

In the case of Barcelona, it was noteworthy that none of the main variables for the OPD policy was significant in the best model, but their interactions with some business types were. This was because only a few specific commercial sectors accepted the policy. The best model has the following utility functions:

$$U(OPD) = c_{OPD} + tax_{OPD,FO}\, TAX_{OPD,FO} + ciw_{OPD,FO}\, CIW_{OPD,FO} + cew_{OPD,FO}\, CEW_{OPD,FO} + ret1_{OPD,FO}\, RET1_{OPD,FO} + ret3_{OPD,RH}\, RET3_{OPD,RH} + ret3_{OPD,FO}\, RET3_{OPD,FO} \quad (4)$$

$$U(UDC) = tax_{UDC,FU}\, TAX_{UDC,FU} + sto_{UDC}\, STO_{UDC} + dis_{UDC}\, DIS_{UDC} + sch_{UDC,VA}\, SCH_{UDC,VA} \quad (5)$$

$$U(CUR) = cur \quad (6)$$

Table 3. Best model for analyzing the behavior of receivers of goods in Barcelona

Variable	Name	Coefficient	Test-t	P[|Z|>z]
Specific constant of the OPD alternative	c_{OPD}	-3.5985	-9.441	0.0000
Variable worth $TAX_{OPD,FO} = TAX_{OPD}$ (tax incentive offered for using the OPD alternative) if the business belongs to the food sector and 0 in other cases	$tax_{OPD,FO}$	6.5835	1.775	0.0759
Dummy variable, $CIW_{OPD,FO} = 1$ if the business belongs to the food sector and the carriers deliver the goods to a warehouse inside the business premises and 0 in other cases	$ciw_{OPD,FO}$	2.5203	5.188	0.0000
Dummy variable, $CEW_{OPD,FO} = 1$ if the business belongs to the food sector and the carriers deliver the goods to a warehouse outside the business premises and 0 in other cases	$cew_{OPD,FO}$	2.5398	4.931	0.0000
Dummy variable, $RET1_{OPD,FO} = 1$ if the business belongs to the food sector and the carriers deliver the goods to the premises between 22.00 and 24.00 and 0 in other cases	$ret1_{OPD,FO}$	1.9469	2.973	0.0030
Dummy variable, $RET3_{OPD,RH} = 1$ if the business belongs to the hostelry sector and the carriers deliver the goods to the premises between 4.00 and 6.00 and 0 in other cases	$ret3_{OPD,RH}$	1.5871	2.015	0.0439
Dummy variable, $RET3_{OPD,RH} = 1$ if the business belongs to the food sector and the carriers deliver the goods to the premises between 4.00 and 6.00 and 0 in other cases	$ret3_{OPD,FO}$	1.7889	2.712	0.0067
Variable worth $TAX_{UDC,FU} = TAX_{UDC}$ (tax incentive offered to the business for using the UDC alternative) if the business belongs to the furniture sector and 0 in other cases	$tax_{UDC,FU}$	11.5315	2.693	0.0071
Reduction of stock held in the business warehouse because space is available for storage at the UDC	sto_{UDC}	1.4030	1.956	0.0505
Variable worth $SCH_{UDC,VA} = SCH_{UDC}$ (timetable for distribution from the UDC to the business) if the business is non-specialist retail and 0 in other cases	$sch_{UDC,VA}$	1.4214	2.444	0.0145
Distance from the UDC to the business	dis_{UDC}	-0.0235	-6.148	0.0000
Standard deviation of the variable DIS_{UDC}	Ns_dis_{UDC}	0.0328	7.131	0.0000
Specific constant of the CUR alternative	cur	0.2154	0.763	0.4456
Nº observations		1200		
Log-likelihood		-725.1		

Table 3 shows the estimation of the best ML model with repeated observations and interaction between the variables and the type of commercial activity.

4. Behaviour of the receivers of goods in Santander and Barcelona

After finding the model able to predict the response of businesses to the different policies being studied, various scenarios need to be proposed in order to evaluate the degree of acceptance of each policy. It should initially be pointed out that the policies will be studied separately, in other words, the degree of acceptance of each one of the policies will be evaluated for each of the proposed scenarios. The reason for this is that it does not appear reasonable to simultaneously introduce a night time goods distribution policy at the same time as using an urban distribution centre, because, in the latter the main movement of goods (bringing them to the cities) is also made during the night. Therefore, the scenarios being studied must be established for both the OPD policy and for the urban goods distribution centres.

4.1. Behaviour of receivers of goods with the OPD policy

Different levels can be established for the variables which intervene in the utility function of nocturnal distribution. Three levels have been considered for the tax incentives, these were offered as a reduction in the taxes that the business has to pay to the administration: no incentives (0%), 5% and 10%. The method by which the goods are delivered is simulated from the dummy variables considered in the model, one of them takes the value of 1 and the others take 0.

For Santander, it was necessary to consider the particular case of the food sector where the incentives affected more than in other sectors. All of the above results in a total of 15 scenarios (5 levels for tax incentives, 2 of them for food sector, and 3 ways for delivering the goods). Table 4 presents the percentage of businesses using the OPD policy in Santander for each of the scenarios being considered.

Table 4. Percentage of businesses willing to use the OPD in Santander for each scenario considered

	$CIW_{OPD} = 1$	$CEW_{OPD} = 1$	$RET1_{OPD} = 1$
$TAX_{OPD} = 0\%$	5.28%	7.82%	3.83%
$TAX_{OPD} = 5\%$	7.63%	11.18%	5.59%
$TAX_{OPD,FO} = 5\%$	9.11%	13.25%	6.70%
$TAX_{OPD} = 10\%$	10.93%	15.74%	8.07%
$TAX_{OPD,FO} = 10\%$	15.30%	21.57%	11.45%

In Barcelona there are 4 possible ways of delivering goods, considering the same 3 levels of tax incentives described above as well as interaction between the variables and two commercial sectors (food and hostelry). Nevertheless, given that the mode of delivering goods has no influence for commerce in general and for the hostelry sector the only interaction was found when deliveries are made between 4:00 and 6:00 requiring the presence of the manager, 6 different methods of delivery were considered (as shown in table 5). A total of 18 different scenarios are considered and Table 5 shows the percentage of businesses using the OPD policy in Barcelona for each of them.

The results obtained show how as the fiscal incentive increases the businesses are more willing to adopt the OPD policy. This is more so in Santander (in Barcelona the incentive only has a positive effect for the food sector). Similarly, the businesses are more willing to use the OPD policy if it is the haulier that places the goods into their

storage facility without requiring the physical presence of an employee of the business (whether this is external storage or inside the business premises).

Table 5. Percentage of businesses using OPD in Barcelona for each scenario considered

	General	$CIW_{OPD,FO} = 1$	$CEW_{OPD,FO} = 1$	$RET1_{OPD,FO} = 1$	$RET3_{OPD,RH} = 1$	$RET3_{OPD,FO} = 1$
$TAX_{OPD} = 0\%$	2.16%	21.52%	21.85%	13.39%	9.74%	11.66%
$TAX_{OPD} = 5\%$	2.16%	27.87%	28.26%	17.88%	9.74%	15.68%
$TAX_{OPD} = 10\%$	2.16%	35.25%	35.69%	23.48%	9.74%	20.76%

The use of incentives in the food sector is particularly interesting in Santander, because it is possible to increase by between 2% and 6% (depending on the way of delivering goods) the number of businesses willing to accept the policy compared to the other commercial sectors.

In Barcelona, however, the way goods are delivered only has an influence in the food and hostelry sectors. The use of warehouses is particularly interesting in the food sector, because an additional 8% to 15% of business can be encouraged (depending on the tax incentives and whether or not the delivery time requires the presence of a staff member) to use the OPD policy compared with the case where the business has to receive the goods during the night.

4.2. Behaviour of receivers with the UDC policy

As with the case presented above, the UDC policy will consider three levels of fiscal incentives: no incentives (0%), 5% and 10%. Three levels will also be considered for different distances between the UDC and the business: short distance (80 m.), medium distance (350 m.) and long distance (750 m.).

As in the case of Santander interaction exists between the variables and the businesses in the food and hostelry sectors, the textile sector and the furniture sector, the same three levels will be considered exclusively for each of these commercial sectors. This makes a total of 12 distance levels (3 for all the businesses and three for each specific sector).

Therefore, a total of 36 scenarios (3 levels of tax incentive and 12 distance levels between the UDC and the business) are considered for Santander. Table 6 presents the percentage of businesses which use the UDC policy for each one of the scenarios being considered.

Table 6. Percentage of businesses using the UDC in Santander for each scenario considered

	80 m.				350 m.				750 m.			
	Gen. (%)	RH (%)	TX (%)	FU (%)	Gen. (%)	RH (%)	TX (%)	FU (%)	Gen. (%)	RH (%)	TX (%)	FU (%)
$TAX_{UDC} = 0\%$	21.63	21.63	23.77	41.36	19.40	19.40	29.10	55.89	16.43	16.43	38.15	58.59
$TAX_{UDC} = 5\%$	26.68	35.56	29.14	45.18	24.09	32.49	35.12	56.98	20.58	28.21	44.85	59.10
$TAX_{UDC} = 10\%$	32.43	52.45	35.15	49.04	29.50	49.03	41.64	58.05	25.47	43.99	51.74	59.60

In the case of Barcelona interaction exists between the variables and the businesses in the furniture sector and the non-specialist retailers. However, as the incentive only influences the furniture sector three levels will be considered for the distance between the UDC and the business (short, medium and long distance) as well as three levels for the

reduction of stock held on the business premises as a result of having space available at the UDC: no reduction (0%), 30% and 60%.

These 9 scenarios are provided for: general commerce, the furniture sector with two levels of incentives (5% and 10%, the zero incentives case is the same as for general commerce) and for the case where the delivery from the UDC to the none specialist retailer is made in the morning (for the afternoon delivery the case is identical to that of general commerce). Thereby making a total of 36 scenarios addressed in Barcelona. Table 7 shows the percentage of businesses that use the UDC policy in Barcelona for each of the scenarios that were considered.

Table 7. Percentage of businesses using the UDC in Barcelona for each scenario considered

	General			$TAX_{UDC,FU}$ = 5%			$TAX_{UDC,FU}$ = 10%			$SCH_{UDC,VA}$ = 1		
	80m. (%)	350m. (%)	750m. (%)	80m. (%)	350m. (%)	750m. (%)	80m. (%)	350m. (%)	750m. (%)	80m. (%)	350m. (%)	750m. (%)
STO_{UDC} = 0%	25.34	23.41	23.50	31.51	24.95	24.22	38.25	26.55	24.96	41.53	27.32	25.31
STO_{UDC} = 30%	29.78	24.53	24.03	36.38	26.12	24.76	43.43	27.75	25.50	46.80	28.53	25.85
STO_{UDC} = 60%	34.55	25.68	24.56	41.50	27.31	25.30	48.73	28.98	26.05	52.13	29.77	26.41

A comparison of the results from Santander and Barcelona for the uptake of the UDC policy shows how the distance between the UDC and the business has a negative, although not excessively important, effect on uptake. Nevertheless, it is interesting to note that because they consider it a negative factor in their immediate area and they don't use it much, the businesses in the textile and furniture sectors in Santander prefer the UDC to be located further away from their premises.

It is also worth noting that while in Santander the level of the tax incentives being offered has a considerable effect on policy uptake in Barcelona it has hardly any effect (except in the furniture sector). Furthermore, being offered their own storage space at the UDC has a considerable effect on the businesses in Barcelona, whereas in Santander it has no importance. This is because in Barcelona the price of real estate is very high making it is economically beneficial to reduce storage space to a minimum, which is not so important in Santander.

It is also worth pointing out that better value for money would be obtained by concentrating resources on certain commercial sectors. In Santander the UDC would be better located closer to the businesses in the hostelry sector, while it could be further away from businesses in the textile and furniture sectors. So by giving tax incentives to businesses to encourage them to take up this policy, it would be more efficient to concentrate the effort on the hostelry sector or on the textile sector rather than on general commerce, and it would not be very beneficial to provide incentives to the furniture sector.

In Barcelona it would be interesting to correctly plan the distribution from the UDC to the businesses, especially the non specialist retail business and much more to the businesses closest to the UDC, given that if the deliveries are made during the morning, uptake can be increased by up to 18%.

Finally, if in the case of Barcelona it is decided to provide tax incentives for using the UDC, these should be given exclusively to the furniture sector (they would have no effect in the other sectors), and especially to the businesses closest to the UDC, among which at the very least uptake of the policy could be increased by 6%.

5. Comparison of the results with those of NYC for OPD

A similar investigation was carried out in NYC (Holguín-Veras et al., 2007; Holguín-Veras et al., 2008), in which the behaviour of both the goods carriers and the goods receivers was analysed in response to a policy aimed at increasing goods distribution during off peak hours. The research used discrete choice models to model their

behaviour using data collected in a stated preferences survey. The policy encouraged the receivers to get involved by offering tax incentives and reduced delivery costs for the companies that were prepared to accept off-peak deliveries.

The research found that the tax incentives offered to the receivers in NYC increased their acceptance of the OPD policy; however the effect was much more noticeable in some specific commercial sectors (wood/lumber, alcohol, paper, medical supplies, printed material, and food). A similar result was found in Santander, where the tax incentives provided to the food sector had a greater effect on uptake than with other sectors. In Barcelona, however, the tax incentives had no influence on the receivers at all, except in the food sector.

Some of the variables that were significant in the NYC model were not so in the Spanish cities (no access to building/freight entrance after hours, additional costs to the business if accepting more OPD), given that the problem of access to building did not exist initially, and the existence of additional receiver costs due to OPD was not significant (the receivers assumed these costs as implicit when the delivery required their presence on the premises).

These results show that, irrespective of the city, the food sector is very willing to participate in OPD policies and especially if there are tax incentives involved. Therefore, similarly to what happened in NYC where a successful pilot test was run with ample receiver participation with the OPD policy, it would be interesting to have a similar pilot test in other cities such as Santander and Barcelona, where it has already been shown that there could be a high level of receiver acceptance.

It would also be beneficial to develop similar practical cases to test the use of UDC, as it has already been shown that in Santander and Barcelona the degree of acceptance of this policy is greater than for OPD, even when the receivers are not offered any tax incentives.

6. Conclusions

This paper has presented the results of research carried out in the Spanish cities of Santander and Barcelona to evaluate the response of goods receivers in urban areas to different policies for delivering the final mile in logistics chains: OPD and using UDC. These results have been compared with those obtained in NYC for the OPD policy.

It was generally found that receivers are against changing the way they get their goods delivered, especially if this involves any additional cost (either in time or money). Nevertheless, with the correct planning, helped at times with tax incentives for receivers willing to take up the policy, a certain degree of acceptance can be achieved, especially in certain commercial sectors.

So, while in Santander up to 7.82% of receivers can be convinced to use OPD without any tax incentives fewer were willing to participate in Barcelona (2.16%). If, however, effort was concentrated on certain specific commercial sectors then greater degrees of acceptance could be achieved still without incentives (21.85% in the food sector in Barcelona). Clearly, these values would increase if incentives were offered, however such incentives are complicated in times of crisis and perhaps more realistic scenarios should be considered.

A comparison of these results with those obtained in NYC shows how tax incentives are a useful measure to increase uptake of the OPD policy. However, these incentives should not be handed out randomly because certain commercial sectors have been shown to be more willing to respond to them. For the two Spanish cities studied, as well as for NYC, the food sector has proved to be, without doubt, the ideal sector on which to provide tax incentives for accepting the OPD policy.

However, receiver acceptance of the UDC is affected by more variables, such as their distance from the commercial premises (which generally has a negative effect on acceptance) or the possibility of having their own storage space at the UDC which would allow them to reduce their stock on their own premises (this variable was only influential in Barcelona where real estate prices are so high that it is very expensive to have storage space on commercial urban land).

If the receivers could be guaranteed having a UDC at least 750 metres from their premises, without providing any incentives 16.43% of the receivers in Santander (and even 38.15% and 58.59% of the textile sector and furniture sector, respectively) and 23.50% of those of Barcelona could be convinced to use them. Clearly, with the use of tax

incentives, above all in Santander, more receivers would be willing to try the system (in Barcelona this would only be true for the furniture sector). Furthermore, if the receivers in Barcelona were offered their own storage area at the UDC more of them would accept the policy, even more with a greater reduction in stock held on their premises. This influence would be even greater at shorter distances (if the UDC were less than 80 metres, then 5% more receivers would be willing to use the policy).

Finally, the non-specialist retailers would be more willing to use the UDC if they had the guarantee that they could receive their goods during the morning. This effect is greater the closer the UDC gets to their premises (at shorter distances than 80 metres policy acceptance increases by 16%).

Sound planning of UFD policies is very important. Targeting the incentives on certain specific commercial sectors which are more willing to change along with the correct planning of the necessary infrastructure (location and equipment) and the running of the centres (time tables, delivery methods, etc.) would result not only in cleaner, healthier cities with lower congestion, it would also optimise the use of available resources.

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